Identifying age- and sex-specific COVID-19 mortality trends over time in six countries: Supplements

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Box S1. Further specificities of the data and data processing

a) COVID-19 deaths with unknown age and/or sex

Data for most countries provide complete information on the distribution of COVID-19 deaths by age and sex. Only the United States and Belgium have some deaths of unknown sex and/or age (1693 and 26, respectively, cumulative since the beginning of the pandemic).
Deaths of unknown age were redistributed proportionally between the age classes. Deaths of unknown sex were dropped from the analyses by sex, but they are included in the analyses for both sexes combined.
Specific sources and other general characteristics of the data for each country are listed in Table S1.

b) Population estimates used to calculate mortality rates

In order to calculate COVID-19 mortality rates by age and sex, we also use population counts disaggregated by those characteristics in each study country. Population estimates for the years 2019, 2020, and 2021 were retrieved from the websites of the national statistics offices of our study populations. These estimates differ between countries in terms of their reference dates. For example, some countries provide estimates for the beginning of the year (e.g., France and Belgium) while others give mid-year estimates (e.g., England and Wales and Scotland). Furthermore, for most countries, we have official population estimates for more than one point in time since the beginning of the pandemic while for the United States we have only one set of population estimates by age and sex for the entire study period.

Table S2 shows the dates referred to by the official population estimates used here. For England and Wales and Scotland, we also used official population projections for 2021 and 2022, as those projections are based on recent population estimates for 2020. For the other countries, the base of the population projections available at the time of writing this article predates the pandemic, so we preferred to use the most recent estimates available for 2020. Using the official population estimates and projections for the dates indicated in Table S1, we estimated the average population size by age and sex in each country at different moments throughout the study period, as illustrated in Figure S2.

Table S1. Sources, general data characteristics, and cumulative number of COVID-19 deaths by the end of the observation period, by country

Country	Source	Type of reference date	Observation period
Belgium	Institut belge de santé (Sciensano)	Occurrence	07/03/2020 – 28/02/2022
England and Wales	Office for National Statistics (ONS)	Occurrence	31/01/2020 – 25/02/2022
France	Centre d'épidémiologie sur les causes médicales de décès (CépiDC)	Occurrence	20/03/2020 – 24/12/2021
Scotland	National Records of Scotland (NRS)	Registration	22/03/2020 – 27/02/2022
Sweden	National Board of Health and Welfare (NBHW)	Registration	12/05/2020 – 28/02/2022
United States	National Center for Health Statistics (NCHS)	Occurrence	04/01/2020 – 23/02/2022

All data are extracted from: "The Demography of COVID-19 Deaths" database (1)

Table S2. Population estimates used in the calculation of mortality rates: Reference dates and total counts (both sexes combined)

Country	Reference dates of estimates	Population counts
Belgium	01/01/2020	11492641
	01/01/2021	11521238
England and Wales	30/06/2019	59439840
	30/06/2020	59719724
	30/06/2021*	59979677
	30/06/2022*	60219165
France	01/01/2020	67454122
	01/01/2021	67626396
	01/01/2022	67813396
Scotland	30/06/2019	5463300
	30/06/2020	5466000
	30/06/2021*	5469387
	30/06/2022*	5470824
Sweden	31/12/2019	10327589
	31/12/2020	10379295
	31/12/2021	10452326
United States	01/04/2020	332599000

Sources: Belgium: STATBEL (2); England and Wales: Office for National Statistics (3,4); France: INSEE (5); Scotland: National Records of Scotland (6,7); Sweden: Statistics Sweden (8); United States: U.S. Census bureau, Population Division (9).

*Population projection from national statistical office.

Table S3. Relative change in cumulative COVID-19 standardized death rate (SDR), for both sexes combined, by season and country

Country	Season and year	First obs.	Last obs.	Rel. change (last /
Belgium	spring 2020	0	77.9	--
	spring 2021	185.1	208.3	1.13
	summer 2020	78.1	82.6	1.06
	summer 2021	208.4	211.7	1.02
	autumn 2020	82.6	141	1.71
	autumn 2021	211.8	226.1	1.07
	winter 2020–2021	141.9	184.8	1.3
	winter 2021–2022	226.5	251.2	1.11
England & Wales	spring 2020	0	81.7	--
	spring 2021	233	240	1.03
	summer 2020	83.7	90.7	1.08
	summer 2021	239.2	246.6	1.03
	autumn 2020	90.5	118.3	1.31
	autumn 2021	246.8	264.1	1.07
	winter 2020–2021	123	231.1	1.88
	winter 2021–2022	264.2	284.5	1.08
France	spring 2020	1.9	43.8	--
	spring 2021	131.5	161.6	1.23
	summer 2020	44.2	46.6	1.05
	summer 2021	161.4	168.5	1.04
	autumn 2020	46.7	80	1.71
	autumn 2021	168.7	174.9	1.04
	winter 2020–2021	84	129.4	1.54
Scotland	spring 2020	0.2	74.3	--
	spring 2021	182.3	189.7	1.04
	summer 2020	75.9	80.2	1.06
	summer 2021	189.2	197.1	1.04
	autumn 2020	79.9	106.5	1.33
	autumn 2021	197.1	225.2	1.14
	winter 2020–2021	110.5	180.2	1.63
	winter 2021–2022	225.7	245.8	1.09
Sweden	spring 2021	113	127.9	1.13
	summer 2020	40.5	53.9	1.33
	summer 2021	128	131	1.02
	autumn 2020	54.1	64	1.18
	autumn 2021	130.5	134.6	1.03
	winter 2020–2021	66.3	111.9	1.69
	winter 2021–2022	134.1	145.6	1.09
United States	spring 2020	0	41.1	--
	spring 2021	202.5	219.6	1.08
	summer 2020	42.9	69.8	1.63
	summer 2021	220.5	237.3	1.08
	autumn 2020	71.6	104.9	1.46
	autumn 2021	242.2	288.6	1.19
	winter 2020–2021	111.9	200.1	1.79
	winter 2021–2022	291.3	352.4	1.21

Notes: Relative change calculated as the SDR on the last date compared to the SDR on the first date available for each season. Data for France (winter 2021–2022) and Sweden (spring 2020) are missing due to data availability. The relative change for spring 2020 is omitted, as the ratio of the last to first available observations results in a very large number because the denominator is close to 0.

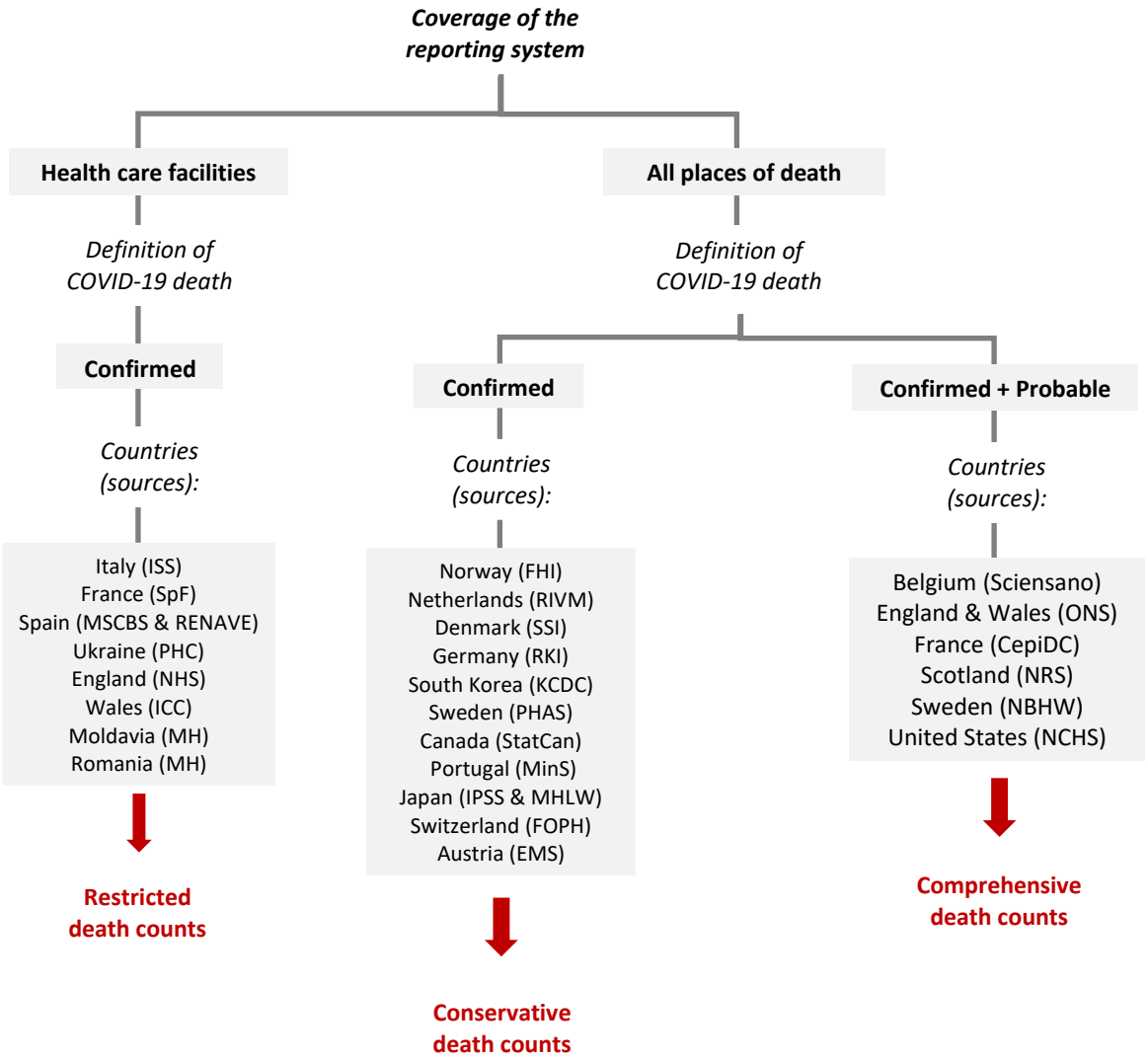


Figure S1. Classification of data sources in "The Demography of COVID-19 Deaths" database, based on definition and data coverage

Notes: For some countries, data come from more than one source. Each source is classified according to its definition of COVID-19 and degree of data coverage. This classification results in three groups of data sources, those that provide: 1) *comprehensive* COVID-19 death counts; 2) *conservative* COVID-19 death counts; and 3) *restricted* COVID-19 death counts (10).

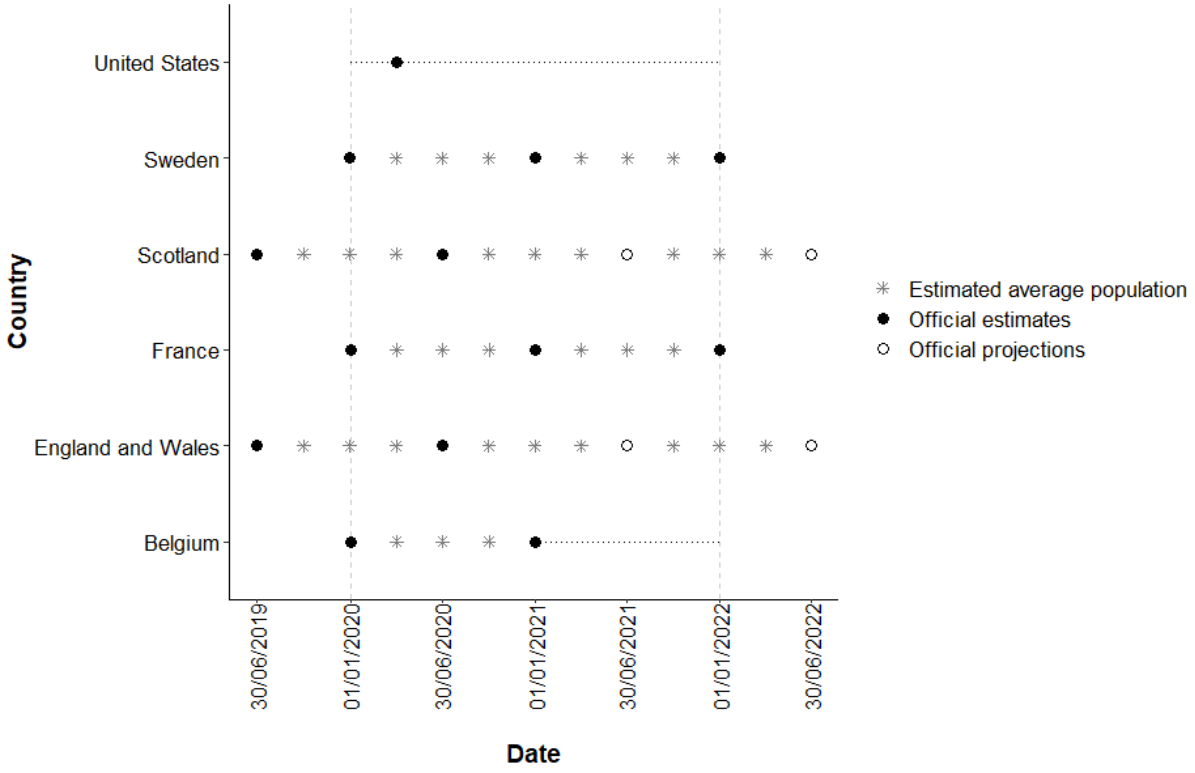


Figure S2. Date and type of population counts used

Sources of official estimates: Belgium: STATBEL (2); England and Wales: Office for National Statistics (3,4); France: INSEE (5); Scotland: National Records of Scotland (6,7); Sweden: Statistics Sweden (8); United States: U.S. Census Bureau, Population Division (9).

Notes: To be able to estimate COVID-19 mortality rates throughout the years 2020–2021, we estimated population size by age at various points during this period. Average population estimates are obtained as the average between two sets of counts, for each sex and age group. For Belgium, official estimates for January 1 2021 are used for all of year 2021. For the United States, population estimates for April 1 2020 are used for the entire study period (i.e., the years 2020 and 2021). Other population estimates and projections for the United States (available at the U.S. Census Bureau website at the moment of writing this article) were not used, as those are based on the 2010 census.

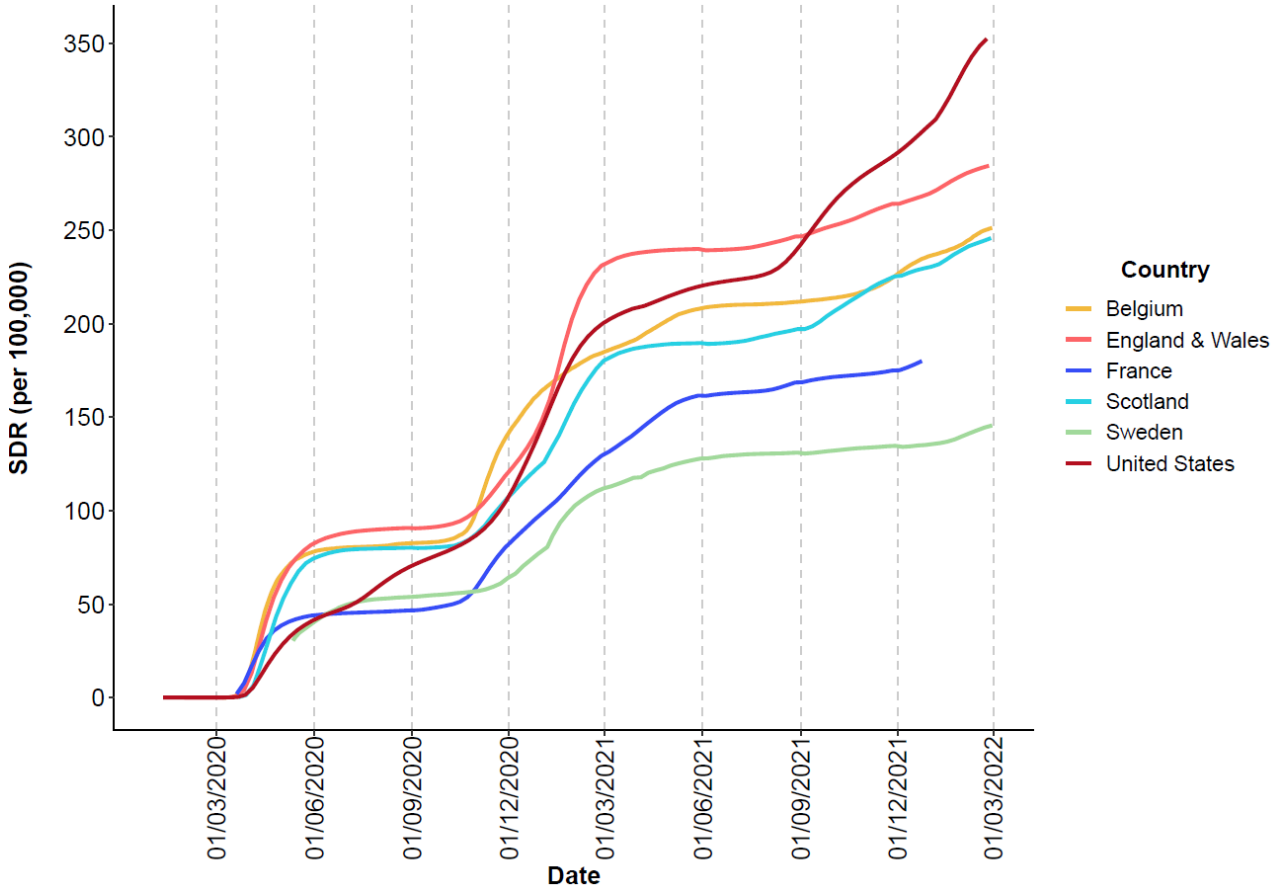


Figure S3. Cumulative COVID-19 age-standardized death rates (SDR) in comprehensive-group countries

Note: The vertical lines indicate the start of each season, based on the meteorological definition (i.e., winter starting December 1st, spring on March 1st, summer on June 1st, and autumn on September 1st).

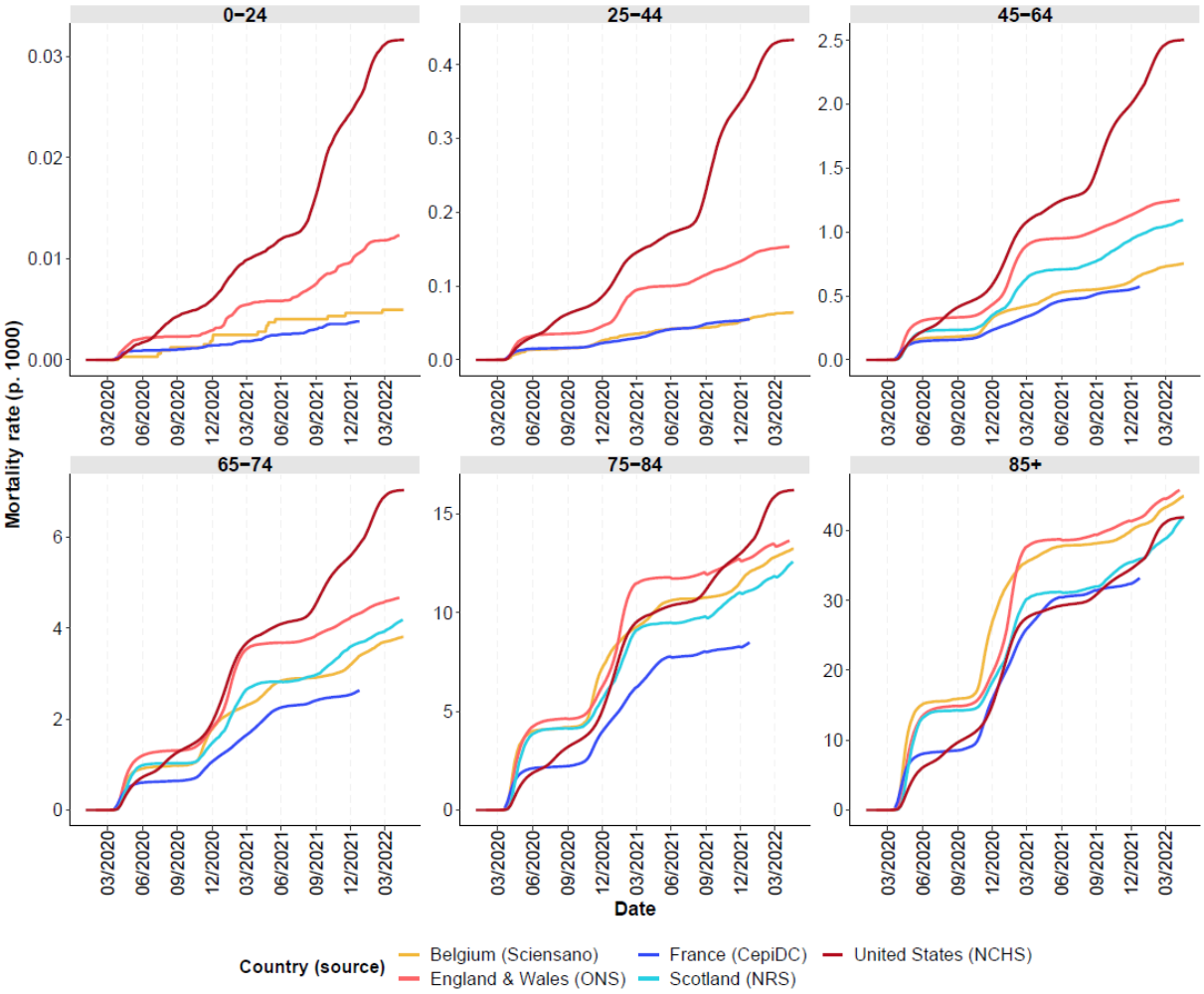


Figure S4. Age-specific COVID-19 mortality rates in study countries, cumulative over time, for both sexes combined

Note: Data for Scotland (ages 0 to 44) and Sweden are not included due to different age groupings. Some results by age for these countries are included in Figure S5.

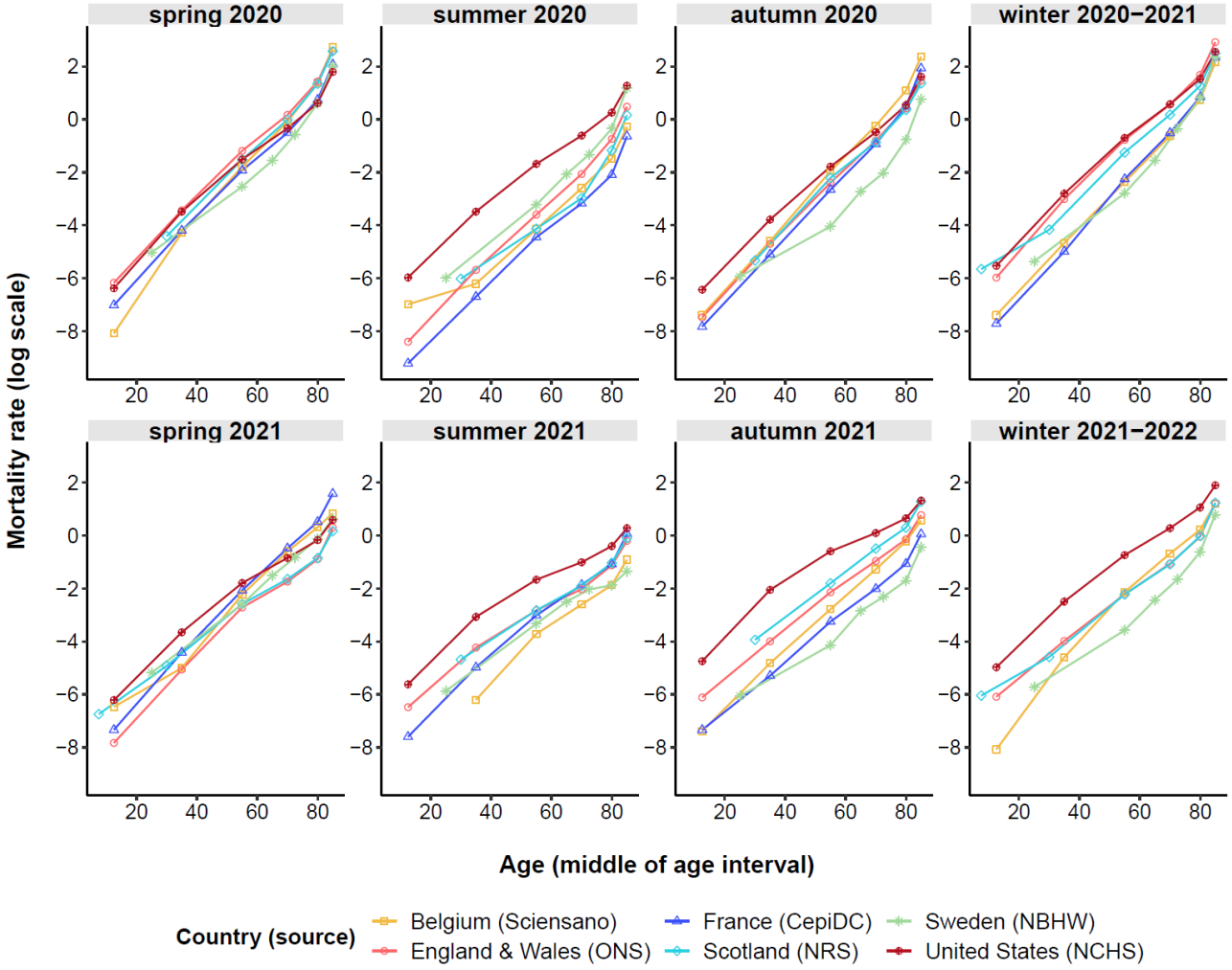
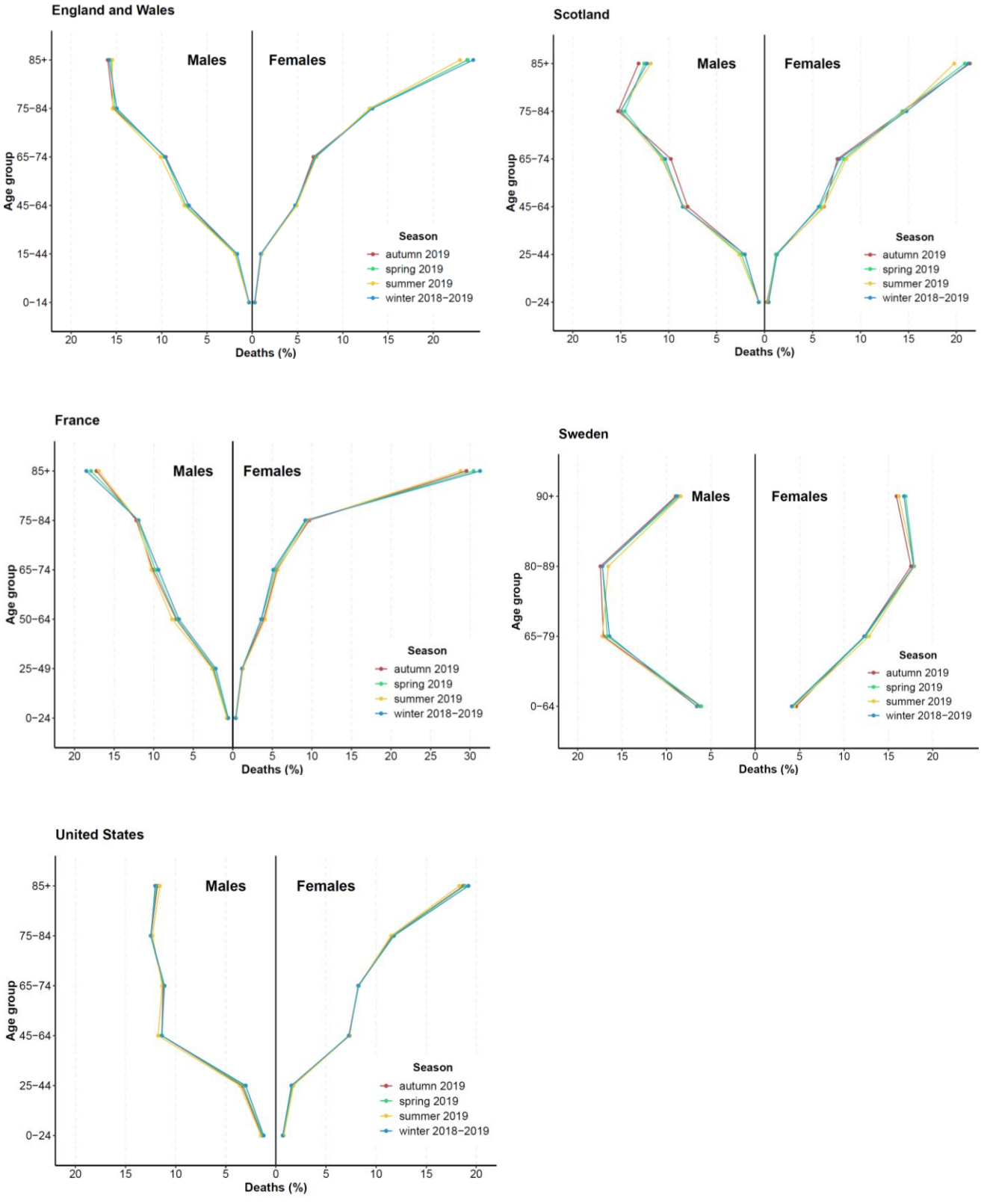


Figure S5. Age-specific COVID-19 mortality rates by sex and season

Note: For Sweden, the point at the youngest age corresponds to age group 0–49.

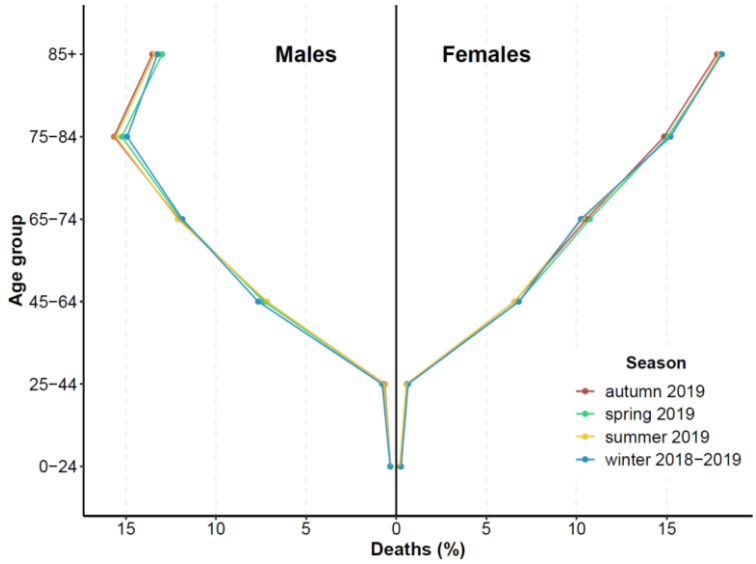
Figure S6. Age and sex distribution of deaths in 2019 (all causes combined) in study countries, by season



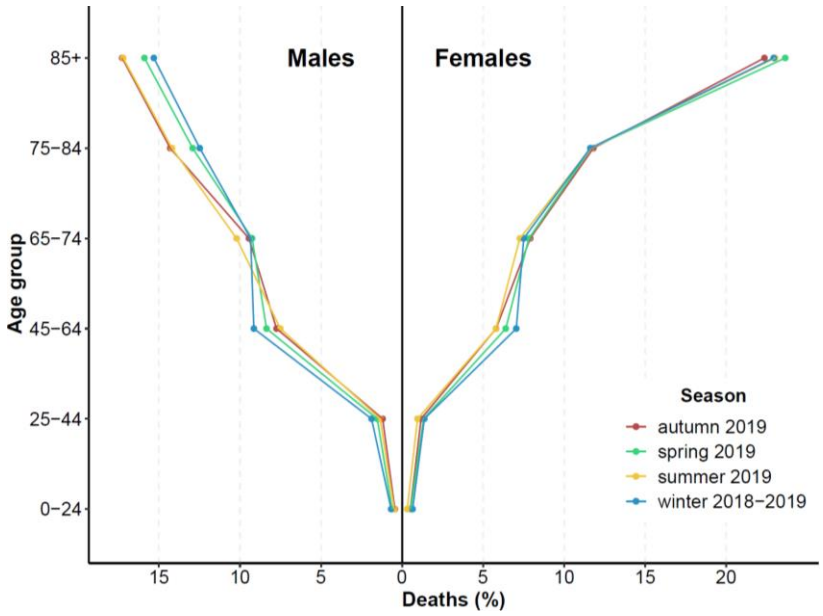
Sources: England and Wales: Office for National Statistics (ONS); France: INSEE; Scotland: National Records of Scotland (NRS); Sweden: Statistics Sweden; United States: Centers for Disease Control and Prevention (CDC).

Figure S7. Age and sex distribution of respiratory deaths in the United States in 2019, by season

a) All respiratory diseases (ICD-10 codes J00-J98)



b) Influenza and Pneumonia (ICD-10 codes J09-J18)



Sources: Centers for Disease Control and Prevention (CDC).

Note: Due to limitations in data availability, Figure S7 is only available for the United States. Panel a indicates that the age and sex structure of respiratory deaths in the United States varied only slightly between seasons in 2019. As for influenza and pneumonia (panel b), we observe a slight decrease in the proportion of those deaths at the oldest ages during winter (especially among males of ages 75 and above), which is compensated by an increase among young adults (ages 45-64).

References

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10. García J, Torres C, Barbieri M, Camarda C, Cambois E, Caporali A, et al. Differences in COVID-19 Mortality: Implications of Imperfect and Diverse Data Collection Systems. *Population* 2021; 76(1): 35-72.